U.S. Department of Agriculture Agricultural Research Service
October 1983

Agricultural Research

Replenishing Our Human Resources in Agriculture

Despite our outstanding advances in agricultural technology and the current surpluses of some agricultural commodities, many recent studies—both public and private—have questioned the ability of American agriculture to meet future demands for food and fiber.

Today, about 22 million Americans work in some phase of agricultural production, processing, or distribution. They make agriculture and its related industries our largest business. To sustain and expand this world leadership, we need a steady flow of graduates in the food and agricultural sciences for such careers as research, banking, and business management, to name just a few.

The Agricultural Research Service makes up about 9 percent of the total public and private agricultural research effort in this country. It is essential, therefore, that the agency fulfill its responsibility to attract adequately trained graduates for careers in research and education.

But there are major problems ahead.

According to a recently concluded ARS national study on the relationship between the supply of and demand for graduates in the food and agricultural sciences, the United States will be facing significant shortages of scientific and professional expertise in food and agriculture over the next decade. K. Jane Coulter, director of the agency's higher education programs and coordinator of the study, says that baccalaureate enrollments are declining in U.S. colleges of agriculture, and the competition among disciplines for students is increasing as the available pool of high school graduates continues to shrink.

In fact, shortages of trained people for available agricultural jobs have already appeared—primarily at the graduate levels—in agricultural engineering, food sciences, agricultural business and management, molecular biology, and plant and animal genetics. Competition among public and private research institutions for well-trained individuals continues to accelerate.

The ARS higher education study is also the first coordinated national effort to determine how many women and minority members are college students and graduates in the various food and agricultural sciences, and how many are currently working in scientific and professional food and agricultural positions.

Employment trends throughout the 1970s indicate that the participation of both women and minority members has increased in food and agricultural occupations. Women, however, have outpaced minorities both in numbers and percentage in increased involvement in this field.

The study shows that between 1950 and 1980, the number of women earning baccalaureates and first-professional degrees (such as doctor of veterinary science) doubled. In 1979, 38 percent of the baccalaureate graduates, 33 percent of the masters graduates, and 14 percent of the doctoral graduates in the food and agricultural sciences were women.

In contrast, minority members make up only about 3 percent of the total number of students enrolled in the food and agricultural sciences, 4 percent in all doctoral and master's programs and 3 percent of all baccalaureate programs. This suggests that disciplines other than agriculture are attracting more of these students.

The trends of declining enrollments and waning interest in scientific and professional careers in the food and agricultural sciences warrants attention of the entire Federal-State-private industry food and agriculture system.

For its part, ARS has instituted several programs to recruit and develop candidates for professional positions. Also, special outreach and recruitment efforts are underway to inform students of employment opportunities in ARS.

A Research Associates Program seeks to attract new graduates by offering opportunities to perform high-priority research. Already in 1983, 21 new Ph.D.'s have been hired to work on 21 research projects specially selected from 189 proposals submitted by veteran ARS scientists nationwide. All of these projects will be funded at a level 75 percent higher than last year as a way to widen support for basic agricultural research and to encourage new scientific talent.

Besides the Research Associates Program, there are several other ARS programs to help bring well-trained agricultural professionals into the agency. A few of them are—

- The Federal Junior Fellowship Program,
- The Cooperative Education Program, and
- The Research Apprenticeship Program.

ARS is actively seeking women and minorities and all qualified candidates to fill professional positions. In order to survive in this competitive arena, ARS will continue to develop stimulating research opportunities that will encourage talented people to pursue careers in agriculture. Only in this way can we help to replenish agriculture's human resources.

Terry B. Kinney, Jr.
Administrator, ARS

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Cover: A Rangeland Improvement Machine developed by ARS in cooperation with Montana State University promises to increase grass and forage yields on the semiarid rangelands and marginal pasturelands in northern Great Plains. Story begins on p. 8. (0782X824-20A)

The Case of the Disappearing Pesticides

Soil microbiologist Donald D. Kaufman collects and measures carbon dioxide as it is released from soil samples treated with different pesticides. The rate at which pesticides decompose and are partially converted into carbon dioxide could reflect the rate of their overall degradation. (0883X1079-13).

Microorganisms that live in the soil are among the most efficient recyclers on Earth. They decompose nature's litter and mankind's refuse into compounds essential to plant and animal life as well as their own survival.

But in the case of a growing number of soil-incorporated pesticides, some microorganisms are becoming too efficient: they are reducing the effective life of these compounds from months to days. As a result, some farmers have little or no pest control.

Mounting evidence points the finger at repeated use of the same or chemically similar pesticides, according to ARS soil microbiologist Donald D. Kaufman, who has spent 21 years studying the action of microorganisms on pesticides at the Pesticide Degradation Laboratory, Beltsville, Md.

Repeated pesticide use causes a buildup of microorganisms that are capable of rapidly degrading these compounds. "A microorganism that adapts to utilize one chemical can quickly adjust to utilize a similar chemical," he explains. Adding to the problem, certain pesticides can prime the enzyme systems of soil microorganisms to use similar compounds even though the original pesticides are not broken down.

Kaufman suspects that because many of these chemicals are formulated as slow-release granules they provide the microorganisms with a slow, steady food supply to keep their inflated populations going. In addition, the systemic pesticides become tied up in plant tissue and are released as the plants decompose.

The loss of pesticide efficacy was the subject of a 2-day workshop hosted by Kaufman at Beltsville last August. Thirty-six scientists from ARS, midwestern and southeastern universities, and the pesticide industry met to exchange information and to determine what data need to be gathered.

One major question: How much acreage is suffering from premaure pesticide degradation? No one really knows. What looks like a case of accelerated degradation may be due instead to pest resistance; conversely, acreage that does not appear to have an efficacy problem may simply not

have a pest problem. In short, accelerated degradation has to be verified in each case.

A few statistics and rough estimates help to demonstrate the scope of the problem, however. According to Jon Tollefson, associate professor of entomology at Iowa State University, Iowa corn farmers began reporting that Furadan® was not controlling corn rootworm in 1974—5 years after the product had been put on the market. It was used on 21 percent of Iowa farmland devoted exclusively to corn, which accounts for about half of Iowa's corn acreage. As word spread about the Furadan® problem, the amount of corn acreage treated with the pesticide dropped 69 percent—from 1.5 million acres to 400,000 acres in 1982.

Alex R. Martin, professor of weed science at the University of Nebraska, together with colleagues Fred Roeth and Robert Wilson, first got involved in studying microbial degradation in 1978 after corn farmers complained that the herbicide Eradicane® was not controlling shattercane. Martin estimates that more than half the 200,000 acres where farmers used Eradicane® continuously (without rotation) are affected. Later, reports of efficacy problems emerged with a structurally similar herbicide, Sutan®, which was used on 500,000 acres in 1978. Martin estimates that less than half this acreage is affected, however, because corn is rotated with other crops, and because Sutan® is also slower to enhance microbial degradation than Eradicane® .

This year, Nebraska farmers were able to buy Eradicane Extra® with an extender (a microbial inhibitor) added, but, says Martin, evidence from several years of field plot experiments shows "the extender loses its ability to correct the problem once it is used repeatedly."

Although the problem may have had its genesis in midwestern corn fields, it is no longer restricted to the Midwest, to corn acreage, or to the three pesticides mentioned, which belong to a class of compounds called carbamates. According to Kaufman, weed scientists in the Southeast, prompted by farmers' reports, are beginning to look into accelerated degradation. And the reports

Microbial degradation of herbicides in soil from a frequently-treated field allows weeds to flourish (left), whereas weed-free soil from a field treated only once shows herbicide stability and persistence. (0983X1191-16)

are occurring with soybeans, vegetables, and other commodities where farmers use the same chemical year after year. Further, they are also associated with another class of pesticides—the organophosphates—which are not structurally similar to the carbamates.

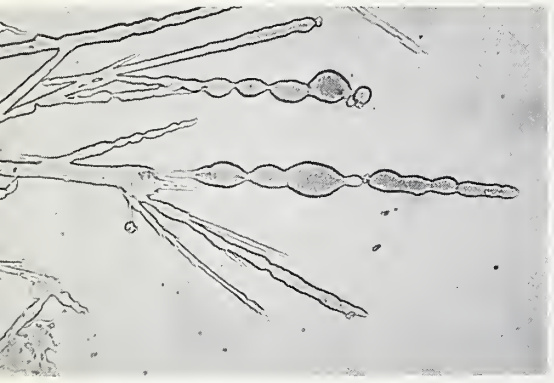
To date, Kaufman has had reports of an efficacy problem with four insecticides, four herbicides, three fungicides, and one nematicide, encompassing 10 major pesticide producers. He has confirmed the link with microbial degradation for half of the pesticides so far. He speculates that the fertilizer, urea, may also be contributing to the problem, indicating that its chemical structure is similar to the core structure of the carbamates.

During the last 4 years, Kaufman has studied numerous problem and nonproblem soils and found that populations of known pesticide-degrading microorganisms are higher in problem soils—sometimes several times higher. When he mixed structurally similar pesticides into the two soils, the pesticides generally broke down more rapidly in the problem soils.

Although these soils have elevated populations of a variety of known degraders, Kaufman says he consistently finds two classes of soil fungi and several bacterial species that are the most active degraders. The bacteria have not yet been identified, but the fungi are from two well-known disease-producing genera—the Verticilia and the Fusaria—which cause root rots and wilts. In a few instances, farmers have reported an increase in these diseases along with a decrease in the pesticide's effectiveness.

Getting a handle on the microbial-pesticide picture will not be easy. The relationships are complicated. For instance, whereas some pesticides enhance the breakdown of similar compounds, others are known to block it. "Like pharmaceuticals," says Tollefson, "we need to understand how the application of one affects the application of others." Kaufman explains that he and other scientists have paid considerable attention to the fate of individual pesticides in the soil microbial environment, but not to the effect of multiple applications of individual pesticides or combinations of pesticides. To fill the gap, he is creating complete soil histories in a telescoped time frame.

In laboratory flasks containing a



A microscope reveals that bacteria isolated from "problem soils" form bulbous colonies over the needle-like crystals of an insecticide as they feed on them. (PN-7069).

variety of soil types, he duplicates all chemicals used on corn and soybeans in many of their various combinations, and records changes in the types and population density of the microflora. The experimental design also allows him to keep a constant fix on changes in the rate of pesticide breakdown because he uses compounds labeled with the radioactive isotope of carbon (^{14}C). As "hot" CO_2 from the degrading pesticide(s) escapes from the soil sample, it can be trapped and measured with a scintillation counter.

Another factor further complicates the microbial-pesticide picture—the crop itself. In a preliminary study, Kaufman compared the rate at which pesticides broke down in soil samples taken from grassland, corn, and soybean fields—each with no history of pesticide use. In fact, all samples came from the same acreage: the grassland was subsequently planted to corn and soybeans. Soil from the soybean field degraded pesticides far more rapidly than grassland soils, whereas soil from the corn field degraded pesticides more slowly than grassland soil.

It appears that each cropping sequence or the crop itself has its own complement of microflora, Kaufman said, and that certain crops encourage the growth of active pesticide degraders.

Kaufman hopes that he and other researchers will be able to devise both a cropping sequence and a chemical sequence that takes the bite out of the degraders, but he predicts that manufacturers will ultimately have to change pesticide chemistry.

For the present, farmers can prevent or at least delay the loss of pest control by rotating both crops and pesticides, although the long-range effects of these procedures are not currently known. Further, they should make sure they indeed have a pest problem serious enough to warrant applying pesticides, and not use the chemicals as preventive medicine.

In the case of pesticides, an ounce of prevention may provoke the need for a pound of cure. Kaufman has found that soils with a short history of pesticide use harbor two or three microorganisms capable of degrading the pesticide. After a long history of pesticide use, however, "almost any microorganism can degrade the compound," he says. "They may be doing their own genetic engineering."

Another phenomenon associated with continuous use may cause problems not only in the root zone but also far below, in the water table. Organic matter in the soil actually impounds pesticide molecules by providing sites to which they adhere. The process, called adsorption, makes the molecules unavailable to microorganisms and also prevents them from leaching into the water table.

With a long history of use, the organic matter becomes saturated with pesticide molecules. (This can occur rather rapidly in soils with a small amount of organic matter.) Because molecules with a similar structure compete for the same adsorption sites, pesticides having a stronger attraction can bump, or desorb, the predecessors off the organic matter and into the microorganisms' mess hall. Those molecules that are not dismantled for "food" could be carried away with moving water.

According to Kaufman, early findings show that repeated use of similar pesticides increases the rate of desorption. If the findings are confirmed in subsequent studies, they could have serious implications for pesticide leaching, he says.

Donald D. Kaufman is located at the Pesticide Degradation Laboratory, Bldg. 050, Beltsville Agricultural Research Center—West, Beltsville, Md. 20705.—(By Judy McBride, Beltsville, Md.) ■

Viruses in Germplasm: Potential Trouble

"In the same way recipients of blood plasma have a right to expect adequate provisions against transfusions contaminated with, for example, hepatitis B virus, users of plant germplasm and the agricultural community at large deserve protection against seed-borne viruses."

Richard O. Hampton, ARS plant pathologist at Corvallis, Oreg., bases this statement on more than 7 years of accumulated evidence that seed-borne viruses may be present in some of the Nation's most important crop germplasm collections.

Using virus detection methods such as the quick, highly accurate technique known as ELISA (see *Agricultural Research*, April 1978, p. 13), Hampton and other researchers both in and outside ARS have detected virus contamination in germplasm accessions of several major crops, including peas, beans, and lentils. Germplasm resources of U.S. crops with the highest market value—corn, soybeans, and wheat—are also considered likely to contain seed-borne viruses.

Hampton suggests that the ELISA technique is well suited to the task of detecting the presence of viruses early, so they can be controlled.

He says, "Once viruses are detected in germplasm and the incidences are known, the preferred course of action would be to generate virus-free genetic resources from ELISA-monitored mother plants, with care taken to maintain the genetic base of the germplasm source."

As an integral measure for controlling germplasm-borne viruses, Hampton says that first-generation seed increases should be grown in insect-free greenhouses, with additional followup screenings to insure continued freedom from viruses.

As the basis for developing new crop varieties, germplasm is the keystone in the U.S. agricultural system. Contamination of this germplasm with seed-borne viruses could set off a chain reaction of events.

"Seed-borne viruses in germplasm, when undetected and unrecognized, can accompany crop genes into breeding programs. When this occurs, these

viruses constitute biological time bombs, threatening cultivar development, adjacent breeding materials, and surrounding crops," says Hampton.

"When infected germplasm is used by commercial and institutional plant breeders and geneticists, viruses are passed on to breeding progenies along with the genes being sought from the germplasm," Hampton says. Individuals, commercial companies, and institutions risk investment of money, time, and energy in new variety development, and may not discover the presence of seed-borne viruses until these viruses have spread to other breeding lines and require costly eradication measures.

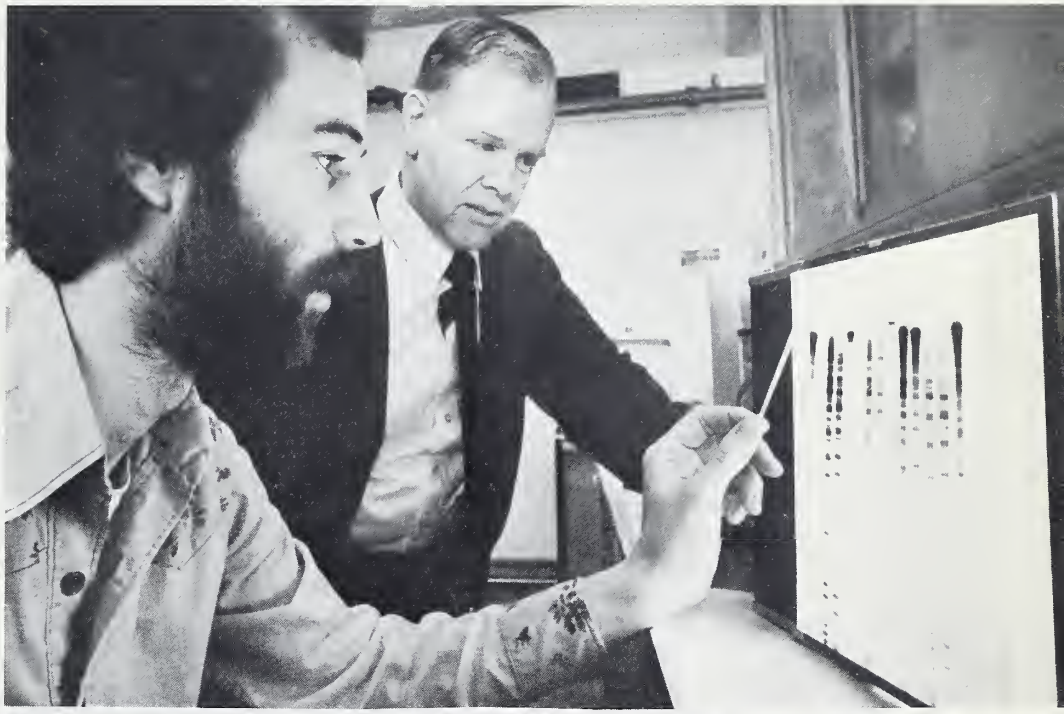
"A second problem is that virus strains not yet common to U.S. agriculture can be introduced and stored in germplasm collections, ready to spread and become established as soon as the germplasm is distributed for use in new cultivar breeding programs.

"Still another problem is that with increasingly stringent international quarantine measures against seed-borne viruses, contamination jeopardizes the market value of U.S. seed exports. This is all in addition to, of course, the actual field losses inflicted on crops by viruses originating in germplasm."

Hampton believes that controlling seed-borne viruses, and eventually all other germplasm-perpetuated diseases, must become "a fundamental part of national and international programs for germplasm stewardship."

As he notes, the cost of controlling a disease in a few grams of seed secluded in a germplasm repository are significantly less than the costs of controlling that same disease once it has escaped into the country's agro-ecosystem.

Richard O. Hampton is located at Cordley Hall, Rm. 4071, Oregon State University, Corvallis, Oreg. 97330.—(By Lynn Yarris, Oakland, Calif.) ■



Top: Graduate research assistant Jeff Ried (foreground) and plant pathologist Richard O. Hampton examine an electrophoretogram to distinguish seedborne from non-seed-transmissable strains of cucumber mosaic virus. (0283X140-21A)

Above: In studies to determine how effectively aphids spread the pea seedborne mosaic virus, Goodell transfers an aphid from infected to uninfected plants. The results: viral transmission rates up to 95 percent. (0283X139-18)

Graduate research assistant Jody Goodell fills microplates with a plant extract solution to be tested—using the ELISA method—for the presence of a pea seedborne mosaic virus strain. (0283X140-6A)

A Machine to Improve Rangelands

Easily pulled by a small (110 hp) tractor, the RIM combines a rototiller, a set of packing wheels, and a seeding drill into one unit that could help revitalize exhausted range and pasturelands on the northern Great Plains. (0782X826-6A)

Currie explains the RIM's unique packing wheel system which he helped design. Several of these steel-plated wheels trail a rototiller to form V-shaped furrows in which grass and forage seeds are then drilled. The gap in each wheel leaves a small dam at 7-foot intervals to help collect and retain water. (0782X826-10A)

A machine that tills and creates water-retaining furrows with intermittent check dams, can, in a single pass, also apply fertilizer and grass and legume seed. Called a Rangeland Improvement Machine, or RIM, by its developers, it shows promise for effectively renovating semiarid rangeland and marginal pastureland.

Livestock producers on the Northern Great Plains want to improve their land to provide more grass and forage for their herds. RIM might be able to double or even triple production under the right climatic conditions.

RIM is composed mostly of commercially available farm equipment. It uses a rototiller to prepare the seedbed, followed by a custom-built packing wheel implement to form furrows with check dams to hold precipitation, and a seeding drill to plant grasses and apply fertilizer.

The rototiller uproots and destroys established or less desirable plant species, which eliminates competition with the newly seeded species, and improves water, nutrient, and sunlight availability.

The packing wheel implement creates a desirable microclimate that encourages germination and plant growth. These wheels form V-shaped furrows about 4 inches deep. A section from each wheel can be removed to form small dams every 5 feet to hold valuable precipitation and prevent erosion when installed on the contour.

The theory is that the increased water the furrows and dams trap can be equivalent to an additional 1 to 1 1/2 inch of rainfall—often enough to mean the difference between seeding success or failure.

The furrows are large enough so they remain intact for several years, but small enough to minimize field traffic problems. Older designs of contour furrowing equipment left fields too rough for vehicular movement.

The drill has individual hoppers and adjustable meters for applying fertilizer and any combination of legume, grass, or small grain seed.

A 110-horsepower, two-wheel drive farm tractor can pull RIM; a crawler-type tractor is not needed. RIM can space rows from 10 to 100 inches in 10-inch increments.

ARS range scientists Pat O. Currie, Fort Keogh Livestock and Range Research Laboratory, Miles City, Mont., and agricultural engineer Lee R. Erickson, Montana State University, Bozeman, tested RIM on a highly saline, bottomland pasture in 1981. Preliminary stand establishment is encouraging.

The following year, the researchers renovated twelve 30-acre plots at two separate test sites typical of many areas in eastern Montana. These plots were on blue grama, western wheatgrass, and needle-and-thread grass ranges that were in poor to fair condition because of past grazing use and the presence of sagebrush, low-growing cactus, and others drought-tolerant species with low forage value.

"While it is too early to evaluate long-term effectiveness of plant establishment, we have seen that RIM is an effective machine concept and early plant establishment looks good when soil moisture is adequate. We are planning additional plot work, testing, and evaluation," says Currie.

Pat O. Currie is located at the Fort Keogh Livestock and Range Research Laboratory, Rt. 1, Box 2021, Miles, City, Mont. 59301.—(By Dennis Senft, Oakland, Calif.) ■

Above: Evaluating the effectiveness of furrows created by the Rangeland Improvement Machine (RIM) in poor-to-fair rangeland, ARS range scientist Pat O. Currie (left) and research associate Tom Hilken of the Montana State Agricultural Experiment Station count seedlings (0782X825-24) and, (top, left), measure their growth. (0782X823-21)

Above: A sheet-metal box contains the flames as White burns a test plot in studies to determine the growth rates of reemerging plants. Plants that survive the burn should resprout vigorously. White's research has rekindled interest in this time-honored technique to revitalize rangelands. (0782X829-19)

Top, right, Plant physiologist Richard S. White measures sagebrush in a test area. Spring burning has been found to increase sagebrush growth, whereas fall burning can reduce sagebrush populations up to 75 percent. (0782X829-35)

Controlled burning on Northern Great Plains rangeland during the fall reduces populations of undesirable shrubs, especially silver sagebrush (*Artemisia tridentata*).

On 30-acre test plots at the Fort Keogh Livestock and Range Research Laboratory, Plant physiologist Richard S. White and range scientist Pat O. Currie reduced silver sage populations up to 75 percent by burning rangeland in the fall under conditions dry enough to produce an intense burn.

Spring burning, on the other hand, was found to increase the growth of silver sagebrush. Burned plants resprouted and new growth exceeded that of the original stand.

"Some people believe that silver sagebrush provides a good habitat for wildlife," says Currie. "Perhaps spring burning might be used on areas where additional shelter and feed are needed for wildlife."

Silver sage can be found on approximately 32 million acres throughout the Western United States, affecting some ranching operations severely, others hardly at all. On the Northern Great Plains it is found on some of the most productive soils. The plant is a problem because it competes with more desirable plant species for limited soil water and also restricts animal access to desirable forages. Sagebrush control by proper burning could be much less expensive

and labor-intensive than herbicide applications.

The scientists also measured the effects of spring and fall burning on the productivity of three important forage species—western wheatgrass, blue grama, and threadleaf sedge.

If grazing land is needed before early June, spring burning should not be done. But if grazing can be deferred until mid- or late June, spring burning may be effective in stimulating forage production. Both spring and fall burning increased the productivity of the three forages studied during this interval. Spring burning, however, usually resulted in higher forage productivity than fall burning.

If grazing can be postponed until summer, the decision to burn should depend upon which species is more abundant. If western wheatgrass is the main forage, burning may not increase production after June. Western wheatgrass plants that were burned dried out faster and provided less standing forage after early June than unburned plants.

In contrast, spring burning substantially increased the productivity of blue grama.

Threadleaf sedge was relatively unaffected by spring burning but was reduced by fall burning.

Burning should not be conducted during droughts that periodically occur on the Northern Great Plains. The combined stresses of burning and drought may either kill or set back valuable grass species.

"Other guidelines to follow include the following: burn only during cool weather and when soils are moist, and keep animals off burned areas until grasses have time to recover," says White.

Because prescribed burning appears to be an effective management tool and because not enough is known for specific recommendations, the studies will continue at Miles City.

Richard S. White and Pat O. Currie are located at the Fort Keogh Livestock and Range Research Laboratory, Rt. 1, Box 2021, Miles City, Mont. 59301.—(By Dennis Senft, Oakland, Calif.) ■

Evaluation of the growth rates of these Herefords under study at the U. S. Meat Animal Research Center indicates that choosing stock on the basis of both yearling weight and muscling score may benefit growth efficiency. (0882X948-20A)

Cattle breeders who select stock on the basis of both the yearling weight and muscling score of their ancestors may find that those animals grow more rapidly with less feed per pound of gain than cattle from ancestors selected for yearling weight alone.

In an 18-year study on Hereford cattle, the weight (at slaughter) of steers from a fast-growing line has generally increased. These steers weigh 100 pounds more than control animals of the same slaughter age, according to University of Nebraska geneticist Robert M. Koch at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, Nebr.

The yearling weights in the study were actually 424-day standardized weights for bulls and 500-day standardized weights for heifers. Muscling score is a visual appraisal of the thickness of muscles in relation to length of bones.

In order to determine the benefit of selecting stock for fast growth at any age, Koch and his team established another breeding line from the same foundation cattle. This line was selected for weaning weights standardized at 200 days with adjustments for age of the dams.

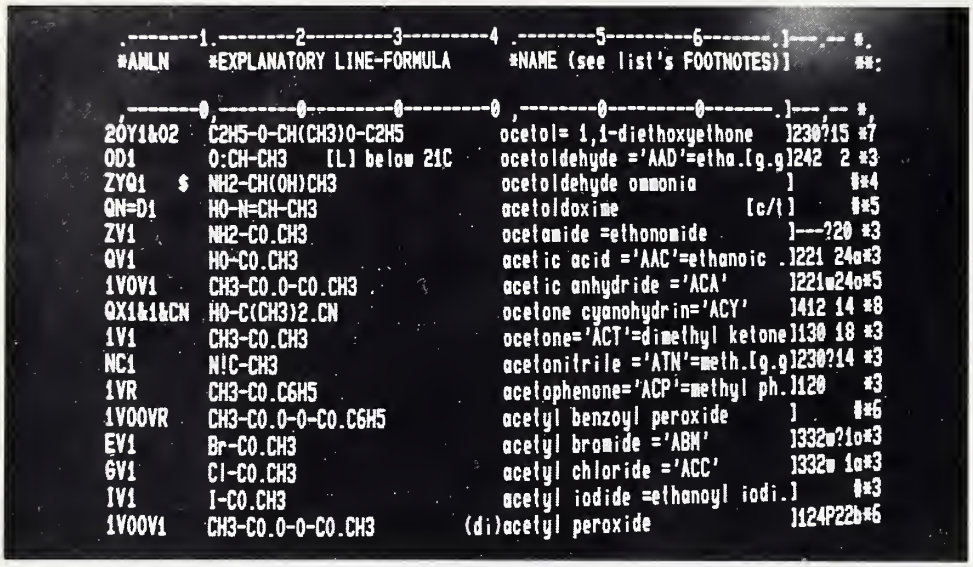
"We found that progress in selecting for growth at any of the different stages resulted in increased growth at the other stages," says ARS research leader Larry V. Cundiff. "Growth during the postweaning period was more highly heritable than growth to weaning."

The researchers constituted the control line in 1971 from the 225 foundation cows and semen from the same foundation sires that were used to begin the study in the early 1960's at the University of Nebraska's Fort Robinson Beef Cattle Research Station.

The average interval between generations of cattle in the project was 4.4 years. This short interval helped speed selection progress, says Koch.

Robert M. Koch is located at the Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, Nebr. 68933.—(By Ben Hardin, Peoria, Ill.) ■

New Language Ushers Chemistry into Computer Age



#AWLN	#EXPLANATORY LINE-FORMULA	#NAME (see list's FOOTNOTES)]	#:
20Y1&02	C2H5-O-CH(CH3)O-C2H5	acetal= 1,1-diethoxyethane	1230?15 #7
OD1	O:CH-CH3 [L] below 21C	acetaldehyde ='AAD'=etha.[g.g]	1242 2 #3
ZYQ1 $	NH2-CH(OH)CH3	acetaldehyde ammonia]	#4
QN=D1	HO-N=CH-CH3	acetaldoxime [c/t]	#5
ZV1	NH2-CO.CH3	acetamide =ethanamide	]---?20 #3
QV1	HO-CO.CH3	acetic acid ='AAC'=ethanoic .	]221 24@#3
1VOV1	CH3-CO.O-CO.CH3	acetic anhydride ='ACA'	]221@24@#5
QX1&1&CN	HO-C(CH3)2.CN	acetone cyanohydrin='ACY'	]412 14 #8
1V1	CH3-CO.CH3	acetone='ACT'=dimethyl ketone	]130 18 #3
NC1	N!C-CH3	acetonitrile ='ATN'=meth.[g.g]	]230?14 #3
1VR	CH3-CO.C6H5	acetophenone='ACP'=methyl ph.	]120 #3
1VOOVR	CH3-CO.O-O-CO.C6H5	acetyl benzoyl peroxide]	#6
EV1	Br-CO.CH3	acetyl bromide ='ABM'	]332@?1@#3
GV1	Cl-CO.CH3	acetyl chloride ='ACC'	]332@ 1@#3
IV1	I-CO.CH3	acetyl iodide =ethanoyl iodi.]	#3
1VOOV1	CH3-CO.O-O-CO.CH3	(di)acetyl peroxide	]124P22b#6

A computer screen displays a page from ARS chemist William J. Wiswesser's Advanced Wiswesser Line Notation (AWLN) system for identifying and cataloging the thousands of new chemical compounds formulated each year. (0183W064-14A)

A headache can be soothed by "QVR b0V1." That's plain aspirin in a new language for chemistry.

William J. Wiswesser, its inventor, says the language simplifies for computers the familiar chemical formulas.

Chemist Wiswesser, located at the Weed Science Research Laboratory, Fort Detrick, Md., foresees no end to the burgeoning number of new chemicals—now reaching over 300,000 a year. Only computers and a simplified system of chemical characters, he says, will be able to keep track of the new formulas as well as the 6 million chemical compounds already known.

His AWLN, short for Advanced Wiswesser Line Notation, addresses this chemical proliferation by using sets of letters, numbers, and punctation marks to designate each individual chemical compound.

Within the new lexicon, isopropyl alcohol, which is rubbing alcohol, is changed from HO-CH (CH3)CH3 to the shorter QY1&1, and household ammonia gets a computer identity of "ZH." Computer designations for other familiar substances are "QV1" for vinegar, "QR bVOI" for wintergreen, and "ODR* dQ c01" for vanilla.

To Wiswesser, the key to devising language symbols is to "stop overlooking the obvious and always keep things simple."

Wiswesser continues to create AWLN designations for complex chemical structures—something he started in 1950. His symbols are now affixed to thousands of compounds. He has seen the earlier WLN become standardized, and play an international role in helping industry and commerce manage rapidly expanding files and inventories of chemicals.

AWLN is a boon to any chemical company that needs to "test hundreds of thousands of new chemicals for biological activity," says Richard Hodgson, Wiswesser's research leader. "Not only must the company record all those compounds, but it also needs to correlate whatever association exists between the arrangement of atoms within a molecule and its biological activity," Hodgson says.

"Such correlations tell the chemist what compounds to lean on and twist around to get them to do what he wants," Hodgson says. "As a rule of thumb, whenever there are more than 2,000 items to sort and compare, computerize."

Hodgson characterizes AWLN as "an unambiguous, searchable, sortable computer language that allows you to enter, store, and retrieve information."

To help keep AWLN unambiguous, Wiswesser retains, wherever possible, the chemical notations taught in chemistry classes. He says his guiding standard is "Zipf's Principle of Least Effort, which favors familiar methods that require the least writing, the least new learning, and the least memorizing."

So "O" still stands for oxygen and "C" is still carbon. But in the new language, the old "Cl" for chlorine becomes "G," receiving a one-letter symbol in common with the other major nonmetallic elements.

The two-letter symbols Wiswesser reserves for metals, thereby making them instantly recognizable. The old "K" and "W" for potassium and tungsten are now "Ka" and "Wo." They join sodium and molybdenum—"Na" and "Mo"—already established as two-letter symbols.

Some of Wiswesser's designations not only provide an identity, but also depict structure. The widely known symbols N2, O2, and CO2 for nitrogen, oxygen, and carbon dioxide molecules become the computer designations NN, OO, and OCO. Now each atom is represented by a letter.

Punctuation marks are reserved as special characters in AWLN to show connections and disconnections at side groups of molecules.

"My aim throughout was to use just one mark for each frequently met atomic group," Wiswesser says. "A smart Las Vegas word gambler would know that such a system would be a winner because the high frequencies of occurrence of nonmetallic groups have been stable for a century."

Wiswesser expects his system to gain its widest acceptance among today's "computer-weaned students, who know from the beginning that 'HH' is a truer picture of hydrogen than 'H2'."

He says tomorrow's chemistry students will quickly recognize that the formula for isopropyl alcohol contains a Y-branched carbon because its formula, HO-CH(CH3)2, will be presented with its matching AWLN: QY1&1. And, he says, they will cope with strange and long names like "N-(2-hydroxyethyl)-thioformamide" and "N-isopropylbenzenesulfonamide" by simply reducing them to their AWLN notation of "SDM2Q" and WSR&MY1&1."

William J. Wiswesser is located at the Weed Science Research Laboratory, P.O. Box 1209, Frederick, Md. 21701.—(By Margaret M. Adams and Russell P. Kaniuka, Beltsville, Md.) ■

Itchgrass: Predicting Its Potential Range

Recognized as one of the world's worst weeds, itchgrass is now well established in the corn, soybean, and sugarcane fields of southern Louisiana. And, as of 1983, infestations of itchgrass are being reported in Florida, Georgia, Alabama, Mississippi, and Arkansas.

However, according to ARS plant physiologist David T. Patterson, itchgrass is unlikely to be a serious early-season competitor with corn or with soybeans outside the South.

Nevertheless, other research shows that itchgrass has some shade tolerance. Therefore, it might become a late-season competitor by germinating and growing under the shade of a developing crop canopy. And should itchgrass become established in areas outside the range where it is competitive with row crops, these infestations might serve as reservoirs for reinfesting areas where the weed has been successfully controlled or eradicated.

The possibility for continuing evolution of itchgrass leading to cool-adapted ecotypes also will be enhanced as itchgrass spreads northward from its present centers of distribution in Florida and Louisiana.

Itchgrass (*Rottboellia exaltata* L.f.) is a robust, aggressive, annual grass that can grow to heights of 8 to 10 feet. Native to India, itchgrass is thought to have first appeared around Miami, Fla., early in the 1900's. Because of its tolerance to atrazine, a popular herbicide used on corn, itchgrass is particularly problematic in corn-growing areas worldwide.

In 1977, Patterson began studies to predict the potential range and agronomic effect of itchgrass in the United States. Using environmentally controlled greenhouses and growth chambers, he grew itchgrass in 36 combinations of temperatures, ranging from 52°F to 72°F at night and 63°F to 90°F during the day. He believes this range of temperatures was sufficient to simulate growing-season conditions throughout the country.

Affiliated with ARS's Southern Weed Science Laboratory in Stoneville, Miss., Patterson's experiments were done at Duke University's Phytotron Controlled Environmental Laboratory in Durham, N.C.

Patterson's research determined that day temperatures below 84°F and night temperatures below 73°F greatly reduced the growth of itchgrass. Nevertheless, within 58 days after emergence, itchgrass produced flowers at day temperatures ranging from 63°F to 89°F and at night temperatures of 57°F or greater.

To estimate the potential distribution of itchgrass, he compared the 36 day and night temperature combinations with average effective day and night temperatures from June through August at 48 locations throughout the country. The growth of itchgrass at each temperature was then computed as a percentage of its maximum growth reached at day and night temperatures of 89°F and 79°F. From these comparisons, he concluded that itchgrass could attain up to 100 percent of its maximum potential growth in the South Atlantic States, the Gulf Coast States, the lower Midwest, and the Southwest, and up to 75 percent of its maximum potential growth in the Middle Atlantic States, the central Midwest, and the Sacramento Valley of California. In cooler areas, such as New England, the northern Midwest, and the Pacific Northwest, itchgrass probably would attain less than 50 percent of its maximum growth.

Patterson's experiments showed that itchgrass could grow vegetatively and produce seed over a wide range of average environmental conditions. However, the effects of temperature extremes, particularly the early spring chilly periods that occur toward the northern limits of its potential range, remained to be studied. Also, the temperature responses of itchgrass needed to be compared with those of the regionally adapted varieties of corn and soybeans with which itchgrass might be expected to compete.

To examine these questions, Patterson grew itchgrass and selected varieties of corn and soybeans in four environmentally controlled regimes to stimulate the first 5 weeks of the growing season for corn and soybeans at Madison, Wis.; for soybeans at Carbondale, Ill.; for corn at Waycross, Ga.; and for soybeans at Baton Rouge, La. Half the plants in each regime were exposed to a 3-day chilling period to simulate naturally occurring early-season chills.

Botanical drawing of itchgrass (*Rottboellia exaltata* L.f.) from *The World's Worst Weeds, Distribution and Biology,* by L.G. Holm, D.L. Plucknett, J.V. Pancho, and J.P. Herberger, East-West Center Books, ©1977, University Press of Hawaii. (PN-7067)

The experiment confirmed the sensitivity of itchgrass to the cool temperatures typical of the early growing season for corn and for soybeans outside the South. In all but the Baton Rouge simulation, the chilling treatments reduced the growth of itchgrass proportionally more than that of the adapted crop varieties, so that weed/crop ratios were significantly decreased by chilling.

Patterson worked in collaboration with Paul C. Quimby, Jr., a plant physiologist at ARS's Southern Weed Science Laboratory in Stoneville, Miss. Charles R. Meyer served as the research technician.

David T. Patterson is currently with ARS's Plant Physiology and Photosynthesis Research Unit, P.O. Box 5155, Raleigh, N.C. 27650.—(By Neal Duncan, New Orleans, La.) ■

Food Choices Provide Zinc for the Aged

(0983L1237-32)

Can the elderly in the lowest 10 percent of the income scale in the United States afford to select those foods sufficiently rich in zinc to meet their daily requirements?

Yes. For most low-income persons, food choices are probably a more important determinant of zinc intake than income, according to a study at the ARS Grand Forks Human Nutrition Research Center, Grand Forks, N. Dak.

Variety meats, such as liver or beef heart, are rich sources of zinc, says medical officer Harold H. Sandstead, director of the Center. Good sources also include veal and other kinds of beef, oysters, dark poultry meat, and crabmeat. For most Americans, the major dietary source of zinc is beef.

"Zinc deficiencies may cause some instances of poor healing of wounds and poor immunity to diseases," says Sandstead. "We don't know the frequency of zinc deficiencies but our concern is based on piecing together information from several studies."

Part of that information comes from studies on how the interactions among various dietary components affect mineral requirements. Through analysis of nutrient-balance data from live-in volunteers of various ages at the Center, scientists have generated an equation that estimates zinc requirements, taking protein and phosphorus intakes into account. They compared these requirements to estimates of zinc intake in the diets of elderly persons who participatead in USDA's 1977 nationwide food consumption survey. They then calculated what the daily cost of zinc-containing foods would be at the grocery store.

The equation estimated that 65- to 74-year-old men in the 1977 survey who consumed 81 g of protein and 1.2 g of phosphorus in their daily diets required 10.05 mg of zinc. Women of the same age range in the survey who consumed 60 g of protein and 0.93 g of phosphorus required 6.49 mg of zinc.

By planning menus and pricing food in a market in Grand Forks in February 1982, the researchers estimated the daily retail food cost for reasonable intakes of zinc to be $1.59 to $1.82. That was near the cost range for diets deemed nutritionally adequate by USDA and defined as thrifty and low-cost food plans. For example, January 1982 food costs for the two plans were $1.79 and $2.29, respectively, for females age 55 and older. From these observations the scientists concluded that for most persons, food choices are probably a more important determinant of zinc intake than income.

However, about 10 percent of the elderly living alone who participated in USDA's 1977 food consumption survey spent an estimated $1.43 or less daily for food. In October of that year food in the low-cost plan cost $1.66 for an elderly woman.

Although the cost comparisons raise doubts about the adequacy of zinc in the elderly's diets, data are insufficient to determine the frequency of deficiency, says Sandstead. There is some clinical and laboratory evidence of increased incidence of zinc deficiencies among the poor.

Sandstead says self-medication with amounts of zinc greater than the recommended dietary allowance may be unwise. Evidence of zinc toxicity has been observed in patients who have received pharmacologic amounts of zinc. He says the interplay among food and drug components that influence bioavailability of zinc needs to be more clearly understood, especially in older persons.

Harold H. Sandstead is located at the Grand Forks Human Nutrition Research Center, P.O. Box 7166, Grand Forks, N. Dak. 58201.—(By Ben Hardin, Peoria, Ill.) ■

Bad News and Good News About U.S. Diet

Many American women may get too little calcium and iron—and men too much salt—in their diets, according to a recent 1-year study of U.S. eating habits.

The study was coordinated by research nutritionist June L. Kelsay and carried out by a team of 15 scientists at ARS's Human Nutrition Center, Beltsville, Md., and the University of Maryland.

"The iron and calcium intakes of the women in the study did not meet the 1980 Recommended Daily Allowances (RDA) of the Food and Nutrition Board," according to Wendy W. Kim, a research team member and nutritionist with the University of Maryland.

The women in the study averaged 12 mg of iron intake per day—33 percent below the RDA—and 700 mg of calcium—12 percent below the RDA. Kim reports that the magnesium intake of the women in age group 36 to 53 was about 25 percent below the RDA. Calcium and magnesium are important components of bones.

The salt (sodium) intake of the men in the study was high when compared with the Food and Nutrition Board's Estimated Safe and Adequate Daily Dietary Intakes of Additional Selected Vitamins and Minerals, says Kim. The men in the 21-to-35 age group ingested about 3,900 mg of sodium per day in their diet, and in the 36-to-49 age group they ingested about 3,400 mg. The recommended intake of sodium for adults ranges from 1,100 to 3,300 mg per day.

On the encouraging side, the scientists found that the cholesterol intake of all groups except males aged 21 to 35 was below the American Heart Association's estimated consumption of 450 to 500 mg per day.

"Other encouraging findings were that the diets exceeded the RDA for protein, vitamins A and C, riboflavin, niacin, thiamin, and phosphorus," Kim reports.

"In our opinion, this study is the most carefully controlled long-term study of the American diet ever done," says Kelsay. "We have collected an enormous amount of information."

The study was conducted from April 1981 through March 1982. Twenty-nine healthy adult volunteers were selected—13 men and 16 women. The volunteers were also grouped by age.

Before beginning the study, the participants were trained in recordkeeping. They were supplied scales and measuring cups for accurate measurement of their normal diets. Each day, the volunteers submitted their diet records to trained interviewers.

To determine the accuracy of the recordkeeping, the participants kept a duplicate of everything that they ate or drank during four 1-week periods. "When the duplicate food samples were chemically analyzed, the results were very close to the information obtained from the daily interviews," Kelsay says.

Kelsay compared the results of the 1-year study to the 1-Day USDA Nationwide Food Consumption Survey of 1977-78. The 1-year study showed a higher intake of calories, carbohydrates, calcium, phosphorus, vitamins A and C, thiamin, and riboflavin than reported in the 1-day study.

The food consumption reported in this study contained approximately 300 more calories per day than reported in the 1-day survey. Since the protein and fat intakes in the two studies were similar, the difference in caloric intakes was mostly due to an increase in carbohydrate consumption.

The information from this study will be especially useful to the Food and Nutrition Board of the National Academy of Sciences when it revises the RDA again in 1986.

June L. Kelsay is located at the Human Nutrition Research Center, Bldg. 307, Beltsville Agricultural Research Center-East, Beltsville, Md. 20705—(By Ellen Mika, Beltsville, Md.) ■

Seed Moisture Levels for Ultracold Storage

Seed from numerous crops can be stored for many years in liquid nitrogen, which has a temperature of approximately −321°F (see *Agricultural Research*, April 1978, p. 14).

The major factor in storage success is lowering seed moisture content before freezing. Seed with too much moisture suffers damage as ice crystals form within the seed during freezing.

Agronomist Phillip C. Stanwood, ARS National Seed Storage Laboratory, Fort Collins, Colo., says freezing damage will not occur if the moisture level is at or below 20.8 percent for barley, 27.2 percent for bean, 25.6 percent for clover, 23 percent for red fescue, 9.3 percent for sesame, 18.2 percent for sorghum, and 26.8 percent for winter wheat.

Conventional storage is in temperature- and humidity-controlled rooms, which are expensive to operate. Liquid nitrogen storage requires only that the liquid be replenished as it slowly evaporates.

Phillip C. Stanwood is located at the National Seed Storage Laboratory, Colorado State University, Fort Collins, Colo. 80523.—(By Dennis Senft, Oakland, Calif.) ■

Learning from a Drought

A severe drought that hit the Northern Great Plains from 1979 through 1981 ruined or delayed several forage and range research projects but unexpectedly gave researchers valuable information about differences in the ability of grass species to survive.

Some native grass species, which have evolved on the Plains, fared much better than some imported species. Other introduced species fared much better and were more drought resistant than some native grasses.

"We don't recommend that farmers and ranchers stop improving their ranges and pasturelands by reseeding introduced grasses that have better growth, higher quality, and excellent adaptability to these areas under normal weather extremes," says ARS range scientist Pat O. Currie at the Fort Keogh Livestock and Range Research Laboratory, Miles City, Mont. But, he says, they should be aware that extended droughts can kill some of these grass species.

Hereford cattle graze lush prairie grasses. In times of prolonged drought these naturally evolved grasses fare better than some introduced species. (SD-756)

Of the nine introduced species, intermediate and pubescent wheatgrasses were virtually eliminated by the extreme drought stress. After they died and normal precipitation returned to the area, weeds rapidly invaded the fields. Crested wheatgrass sustained heavy damage, but is recovering and should provide adequate production. Two varieties of Russian wild ryegrass survived very well and even increased in basal area during the drought.

Of the four native species, all suffered reduced stands. Western wheatgrass proved to be most drought resistant, whereas Sherman big bluegrass was killed. Again, weeds invaded the grass stands, and recovery will be slow even with more normal precipitation.

During the drought, annual precipitation averaged slightly less than 10 inches, compared to about 14 inches during a normal season. All grasses in the test were seeded in October 1978 or April 1979.

Pat O. Currie is located at the Fort Keogh Livestock and Range Research Laboratory, Rt. 1, Box 2021, Miles City, Mont. 50301.—(By Dennis Senft, Oakland, Calif.) ■

Cooling Fans for Apples

Energy used in cold-storage rooms housing Red and Golden Delicious apples could be cut nearly in half using a new fan-cycling scheme devised by an ARS agricultural engineer.

Keeping cooling fans in apple cold-storage rooms on for 6 hours, then switching them off for 6 hours—twice during a 24-hour period—maintains safe Red and Golden Delicious fruit temperatures. The practice uses only 52 to 60 percent of the energy expended when fans are operated continuously for 24 hours, according to agricultural engineer Gilbert Yost, Wenatchee, Wash.

Five years of monitoring different fan-cycling schemes have convinced Yost that, "Overall, the six on—six off is the best scheme." Yost tested 12 hours on—12 hours off, 8 hours on—16 hours off, and 16 on and 8 off, in apple cold-storage rooms ranging from "antiquated" to those featuring "the latest state of the art in construction and equipment."

According to Yost, there is no difference in the quality of apples stored under either a cycled or a noncycled fan: average fruit temperatures are held at 31° to 32°F under both systems.

"Most cold-storage facilities use air-temperature readings to maintain fruit temperatures, which doesn't give a true picture. Fruit temperatures should also be monitored," he says.

At harvest time, fans must run continuously until the field heat is removed from the fruit and proper storage temperature is attained. At this point, Yost says, fan cycling can begin. He suggests that storage-facility owners time their fan-cycling operations to fit the peak-load hours of their local utility companies (when rates could be cheaper.)

"This adjustment won't interfere with the maintenance of optimum fruit temperatures," he says.

Though tested only on Red and Golden Delicious apples, Yost feels his technique should work for other apple varieties as well, but further research is needed.

Gilbert Yost is located at the Fruit Research Laboratory, 1104 North Western Ave., Wenatchee, Wash. 98801.—(By Lynn Yarris, Oakland, Calif.) ■

The Tiller's Not the Answer

Winter wheat's coleoptile tiller, part of the plant that develops farther below the soil surface than other tillers, does not provide wheat plants with resistance to freezing temperatures.

Some people had theorized that the coleoptile tiller, because it starts growth about ½ to 1 inch deeper in the soil than other tillers, would be more insulated from the severe cold that can wipe out wheat crops. Some years, a sizable amount of the northern and central Great Plains wheat crop is destroyed by unusually cold weather conditions.

This information will help geneticists who are seeking ways to improve winter hardiness of wheat—they need not waste valuable time trying to improve coleoptile tiller growth.

ARS agronomist Bohn Dunbar, along with R. Wayne Shawcroft at the Central Great Plains Research Station, Akron, Colo., found that if the weather was cold enough to kill the wheat plant's crown, which grows near the soil surface, the coleoptile tiller also died. Also, if the crown was not killed, neither was the coleoptile tiller.

The scientists used a specially designed chamber to lower the soil temperature near the upper crown to −14°F. They kept the soil temperature near the base of the coleoptile tiller at 15°F.

Bohn Dunbar and R. Wayne Shawcroft (Colorado State University irrigation management specialist) are located at the Central Great Plains Research Station, P.O. Box K, Akron, Colo. 80720.—(By Dennis Senft, Oakland, Calif.) ■